Determinants of child nutrition and mortality in north-west Uganda

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An anthropometric survey of children aged 0–59 months in north-west Uganda in February-March 1987 indicated a high prevalence of stunting but little wasting. Use of unprotected water supplies in the dry season, prolonged breast-feeding, and age negatively affected nutrition; in contrast, parental education level improved nutrition. Mortality during the 12 months following the survey was higher among those who had low weight-for-age and weight-for-height, but children who had low height-for-age did not have higher mortality. Weight-for-age was the most sensitive predictor of mortality at specificities >88%, while at lower specificity levels weight-for-height was the most sensitive. Children whose fathers' work was associated with the distillation of alcohol had a higher risk of mortality than other children. The lowest mortality was among children whose fathers were businessmen or who grew tobacco.

Introduction

Several studies have found that malnutrition increases the risk of childhood mortality. For example, for Bangladesh, Sommers & Lowenstein reported that the risk of mortality for children below the 10th percentile of arm-circumference-for-height was 3.4 times that of children above the 50th percentile (*1*). Also, for India, Kielman & McCord found that mortality decreased exponentially with each 10% rise in the % median weight-for-age (*2*). In Bangladesh, Chen et al. reported that mid-upper-arm circumference and weight-for-age were the best predictors of mortality (*3*), while Briend et al. showed that mid-upper-arm circumference was the best predictor of mortality (*4*). In contrast, studies in Africa have found that anthropometric parameters are weak predictors of mortality (*5, 6*); however, one recent study in south-west Uganda showed that anthropometric indicators are good predictors of mortality, with mid-upper-arm circumference being the most sensitive.[a]

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Malnutrition leads to a higher risk of death, but what are the determinants of malnutrition? Frequently suggested causes are poverty, low parental education, lack of sanitation, low food intake and malabsorption, diarrhoea and other infections, poor feeding practices, family size, short birth intervals, mother's time availability, child-rearing practices, and seasonality. These variables interact to cause inadequate consumption and assimilation of nutrients and a subsequent impairment of health and physiological functions.

The present article reports on the nutritional status in a district of Uganda and on attempts to identify sensitive predictors of childhood mortality; a further aim was to determine the major causes of malnutrition and mortality in the study region.

Methodology

Between February and March 1987, a total of 1178 children aged 0–59 months were selected from 30 villages in the district of Arua, north-west Uganda. The villages were chosen using random sampling with probability proportional to size, based on the 1980 Ugandan census (*7*).

The weight and height/length of the children were measured. Weight was measured to the nearest 100 g using Salter spring scales. The height of each child aged 24–59 months was determined, while length was measured for children below 2 years of age; the measurements were made to the nearest mm using locally constructed height/length boards. The ages of the children were assessed by examining birth and baptismal certificates or local calendars of events.

Socioeconomic and health-related variables were collected from each household using a questionnaire that was distributed to the head of the family and to the mother of the child. The families surveyed were revisited 1 year later to record any deaths that had occurred among the children who had been measured. After being validated, the data were analysed using SPSS software (*8*). The anthropometric measurements were transformed into standard deviation (S.D.) scores and expressed as % deviations from those for the median NCHS reference population (*9*) by means of a software package obtained from the Centers for Disease Control (*10*).

Results

Table 1 shows the prevalence of malnutrition among the study children, by age group. Nutritional status was relatively satisfactory in the first 5 months of life but deteriorated thereafter. The proportion of children who were underweight (low weight-for-age) was greater in the second year of life, but improved thereafter. Wasting (low weight-for-height) was commoner among those aged 6–24 months but was very low for other age groups. Stunting (low height-for-age) was low in the first 5 months of life but reached high levels subsequently.

Mortality rates were around 10% during the first year of life, 3.1% in the second year, 4% in the third year, and about 0.5% thereafter. Mortality was significantly higher at low levels of weight-for-age and weight-for-height but remained the same at different values of height-for-age (Table 2). Compared to a baseline level of ≥–1 S.D., the relative risk for mortality was 3 at <–3 S.D. weight-for-age and 4.6 at <–2 S.D. weight-for-height.

Table 1: **Percentage prevalence of children below different cut-offs for weight-for-age, height-for-age, and weight-for-height, north-west Uganda**

	Age (months)						
Parameter[a]	0–5 (*n* = 108)	6–11 (*n* = 142)	12–23 (*n* = 231)	24–35 (*n* = 187)	36–47 (*n* = 215)	48–59 (*n* = 183)	Total (*n* = 1066)
Weight-for-age							
< –2 S.D.	3.7	31.7	41.6	23.5	20.5	16.9	24.8
< 80%	8.3	40.8	44.2	21.9	23.3	21.3	28
Height-for-age							
< –2 S.D.	9.3	28.9	50.2	48.7	47.9	49.7	42.4
< 90%	6.5	16.2	28.1	29.4	33.5	38.8	27.5
Weight-for-height							
< –2 S.D.	1.9	6.3	7.8	1.6	0	0	3
< 80%	1.9	5.6	3.5	1.6	0	0	2

[a] < –2 S.D. = < –2 standard deviations from the median of the NCHS standard population; <80% and < 90% = percentages from the median of the NCHS standard population.

Table 2: **Mortality levels among the study children according to different cut-offs (in standard deviations (S.D.)) for weight-for-age, height-for-age, and weight-for-age 1 year after the survey**

	S.D. cut-off						
	<–3	<–3.00 to –2.51	–2.50 to –2.01	–2.00 to –1.51	–1.50 to –1.01	>1	χ^2 test
Weight-for-age	8/75 (10.7)[a]	2/74 (2.7)	3/115 (2.6)	4/166 (2.4)	4/174 (2.3)	16/462 (3.5)	*P* <0.001
Height-for-age	6/192 (3.1)	3/119 (2.5)	3/141 (2.1)	5/156 (3.2)	7/132 (5.3)	13/326 (4)	*P* >0.10
Weight-for-height	1/3 (33.3)	1/4 (25)	2/25 (8)	3/63 (4.8)	7/121 (5.8)	23/850 (2.7)	*P* <0.001

[a] Figures in parentheses are percentages.

Table 3: **Percentage mortality levels, by anthropometric intervals, according to age group**

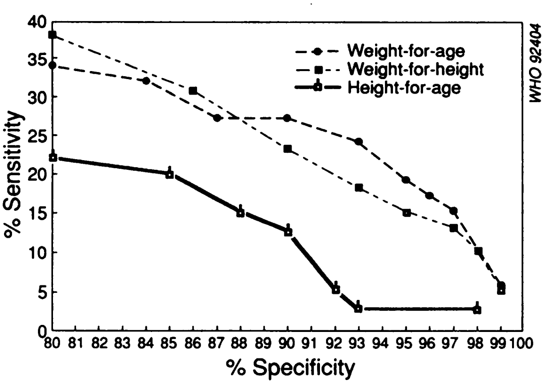
Parameter[a]	Age (months) 0–11	12–23	>23	Total	χ^2 test [b]
Weight-for-age (S.D.)					
< −3	17.6 (17)[c]	11.1 (27)	6.5 (31)	10.7 (75)	$P = 0.48$
−3 to −2.01	15.6 (32)	0 (69)	0 (88)	2.6 (189)	$P < 0.001$
> −2.01	8.5 (201)	1.5 (135)	1.1 (466)	3 (802)	$P < 0.001$
Height-for-age (S.D.)					
<−3	23.1 (13)	4.3 (47)	0.8 (132)	3.1 (192)	$P < 0.001$
−3 to −2.01	10.5 (38)	2.9 (69)	0 (153)	2.3 (260)	$P < 0.001$
>−2.01	9 (199)	0.9 (115)	2 (300)	4.1 (614)	$P < 0.001$
Weight-for-height (S.D.)					
<−2	9.1 (11)	11.1 (18)	33.3 (3)	12.5 (32)	$P = 0.51$
>−2.01	10 (239)	1.4 (213)	1 (582)	3.2 (1034)	$P < 0.001$

[a] S.D. = standard deviation from the median of the NCHS standard population.
[b] The statistical significance relates to a χ^2 test for the equality of death rate across the age groups (within each anthropometric group).
[c] Figures in parentheses are the numbers of children in each age group.

Table 3 shows that below these anthropometric cut-off points mortality was higher for children aged < 12 months.

For each anthropometric parameter, Fig. 1 shows the sensitivity (% of total mortality correctly identified) versus specificity (% of survivors correctly identified). Above 88% specificity, weight-for-age was the most sensitive indicator, while at lower specificities weight-for-height was more sensitive; the least sensitive was height-for-age. The choice of an anthropometric indicator to identify children at higher risk of death therefore depends on the level of specificity. However, there should be as few false positives, as possible, and a high level of specificity; weight-for-age seems to be better in this respect than weight-for-height or height-for-age.

Fig. 1. **Plot of sensitivity versus specificity for the anthropometric parameters in predicting mortality, 1 year after the survey was carried out.**



The only indicator of household and family status that was significantly related to child mortality was the father's occupation. Child mortality was highest when the father's occupation was associated with alcohol distillation, while the lowest mortality was recorded when the father was a tobacco grower or a businessman (Table 4).

Table 5 shows the results of the stepwise multiple regression in which the dependent variables were weight-for-age, height-for-age, or weight-for-height. Father's education was positively correlated with weight-for-age. Age, breast-feeding, use of unprotected water supplies in the dry season, skin infections, and diarrhoea in the 2 weeks before the survey negatively influenced the coefficient of weight-for-age.

Maternal education was positively associated with height-for-age. Age, breast-feeding, use of unprotected water supplies in the dry season, skin infections and diarrhoea were negatively associated with height-for-age.

Father's education was positively associated with weight-for-height, while skin infections were negatively correlated with this parameter. Breast-feeding was negatively associated with all three anthropometric parameters. This association arose because prolonged breast-feeding was associated with lower values of the anthropometric parameters (Fig. 2).

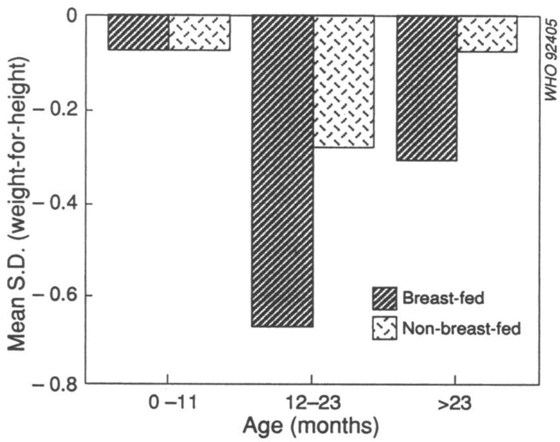
Table 4: **Child mortality and father's occupation in the study population**

Father's occupation	No. of children	% who died 1 year after the survey[a]
Alcohol distillation	138	7.2
Farmer	751	4.3
Businessman	119	0.8
Tobacco grower	22	0
Other	148	2
Total	1178	3.9

[a] χ^2 test, $P < 0.05$.

There was no significant correlation between the anthropometric parameters and the sex of the child, father's occupation, presence of a latrine in the house, degree of crowding, pregnancy of the mother, parents' polygamous relationships, type of storage used for drinking-water, rubbish disposal practices, distance from a health unit, management of type of feeding and of fluid intake during diarrhoea, possession of a health card, and use of unprotected water supplies during the wet season.

Fig. 2. **Plot of mean standard deviations (S.D.) of weight-for-height for breast-fed and non-breast-fed children, by age group.**



ANOVA significance of $F < 0.001$

Table 5: **Study variables correlated with anthropometric measurements (standard deviations) through stepwise multiple regression**

	Regression coefficient for:		
	Weight-for-age	Height-for-age	Weight-for-height
Morbidity in the previous 2 weeks			
Diarrhoea	−0.462[a] (0.170)[b]	−0.423[c] (0.201)	−0.161 (0.142)
Fever	−0.132 (0.153)	−0.148 (0.181)	−0.023 (0.127)
Measles	−0.188 (0.406)	−0.055 (0.480)	−0.252 (0.338)
A.R.I.[d]	−0.287 (0.202)	−0.198 (0.239)	−0.144 (0.168)
Skin infection	−0.729[e] (0.229)	−0.633[c] (0.271)	−0.495[a] (0.191)
Others	−0.380 (0.274)	−0.153 (0.333)	−0.195 (0.234)
Child was breast-fed	−0.856[e] (0.116)	−0.735[e] (0.139)	−0.357[e] (0.065)
Age (months)	−0.025[e] (0.003)	−0.037[e] (0.004)	N.E.[f]
Use of unprotected water supplies during the dry season	−0.223[a] (0.084)	−0.302[a] (0.101)	N.E.
Father's education (years)	0.030[a] (0.009)	N.E.	0.016[c] (0.008)
Mother's education (years)	N.E.	0.039[c] (0.017)	N.E.
r^2	0.10	0.10	0.06
F test	$P < 0.001$	$P < 0.001$	$P < 0.001$

[a] $P < 0.01$.
[b] Figures in parentheses are the standard errors.
[c] $P < 0.05$.
[d] A.R.I. = acute respiratory infections.
[e] $P < 0.001$.
[f] N.E. = Not entered into the model by the stepwise process, because the coefficient did not reach the significant level of $P < 0.05$.

Discussion

Among the study population the nutritional status was relatively satisfactory among those aged < 6 months, but deteriorated thereafter. This was probably due to the onset of weaning, which is often associated with an increased prevalence of diarrhoea. The low prevalence of wasting and high prevalence of stunting could be explained by the different effects that infections have on weight and height. After an acute infection, weight growth often recovers relatively rapidly, but linear growth is slower to recover (*11*), and is prone to setbacks should further acute episodes occur. There is still lack of agreement about the causes of stunting among children in developing countries. However, it is likely to be related to chronic dietary impairments (especially protein–energy but also of micronutrients) compounded by frequent infections. In the study population the high prevalence of stunting suggests long-term nutritional stress. There were few wasted children, which indicates that widespread, severe short-term food shortages were not a problem. Genetic factors may be important in the development of stunting; however, the condition most commonly occurs as the end result of chronic nutritional insufficiency and food infections. Stunting has a multifactorial etiology, having a clear association with poverty and poor living conditions, with no single factor being totally responsible. Thus, we can presume that a reduction in stunting will only result if there is an improvement in socioeconomic conditions, household food security, provision of safe water supplies, sanitation, and other elements of primary health care.

Previous studies in India (*2*) and Bangladesh (*3, 19*) reported that weight-for-age was a sensitive predictor of mortality; in contrast, studies carried out in Guinea-Bissau (*5*) and Zaire (*6*) found that anthropometric indicators were poor predictors. These findings could indicate that in Africa, in contrast to Asia, anthropometry plays a relatively minor role in identifying children who are at a higher risk of death. In our study, low levels of weight-for-age and weight-for-height were significantly related to mortality, confirming that also in Africa anthropometric indicators are sensitive predictors of mortality.

Child mortality was highest in families where the father earned his living from alcohol distillation, and lowest in those where the father was a tobacco grower or a businessman. The reason for this is probably that those involved in alcohol distillation were the worst off socioeconomically, while those who cultivated tobacco or were involved in business were better off. Mosley & Chen suggest that economic wealth can improve child survival through the prevention and cure of diseases, by increasing child-spacing and hygiene practices, by providing improved access to safe water supplies and sanitation, and by increasing the availability of food (*12*). The implication is that changes in all these variables are necessary for an improvement in child survival.

Parental education level, which is usually related to child mortality (*13, 14*), was not so in the present study.

It is useful to consider whether certain variables had a greater impact than others on nutritional status. Stepwise multiple regression failed to demonstrate any correlation between the anthropometric parameters and the following: the child's sex, marital status of the mother, occupation of the father, parents' polygamous relationships, type of storage used for drinking-water, use of boiled water for drinking, disposal of waste-water, presence of a latrine, disposal of rubbish, distance from a health unit, possession of a child health card, whether the child had been weighed in the previous 3 months, or whether the parents knew about the correct feeding and fluids practices to adopt during diarrhoea episodes. Similarly, there was no relation between the anthropometric indices and any history of the child being ill with fever, measles, or acute respiratory infections in the 2 weeks prior to the survey. Variables that negatively influenced the anthropometric coefficients included age, breast-feeding, use of unprotected water supplies during the dry season, skin infections, and diarrhoea in the 2 weeks prior to the survey. The only variable that favourably influenced nutrition was parental education level. The association between prolonged breast-feeding (>12 months) and poor nutritional status has been reported in previous studies (*7, 15–17*). It is possible that prolonged breast-feeding is associated with a lower intake of solids. Production of breast-milk is lower after 12 months' post-partum, and children who are still suckling at this age receive less total protein–energy intake than those who stop breast-feeding earlier. It is also possible that children who are still being breast-fed are reluctant to accept other foods in sufficient quantity, as reported by Brakohiapa et al. in a study carried out in Ghana (*15*). Also, children who breast-fed longer may have belonged to families living under poorer socioeconomic conditions, which affected their nutritional status. However, the multiple regression analysis carried out suggests that this is not the case.

The use of unprotected water supplies during the dry season was negatively correlated with weight-for-age and height-for-age. This could have arisen because, especially in the dry season, the use of polluted water supplies causes spread of infections (particularly diarrhoea), leading to malnutrition. Alternatively, the association could be a proxy indicator of household wealth.

The relationship between parental educational level and nutritional status could be related to health knowledge, but it has been suggested that educational level is an indirect measure of socioeconomic status (*18*). Educational level remained significantly associated with nutritional status after allowing for a range of socioeconomic variables, and we suggest that education *per se* has an important influence on nutrition. Parental educational level could function by lowering fatalistic attitudes to illness, increasing belief in the possibility of changing child health status and the acceptance of new ideas, generating greater confidence in dealing with health professionals, producing more direct responsibility in child-rearing practices, as well as increasing parental health knowledge. Better-educated parents might have been more able to decide on priority actions to be taken in matters such as child immunization. Also, educated parents would probably accept more easily the concept of family planning, be better informed on how to use health facilities, and have shared family resources more equitably, especially in favour of their children; furthermore, they could have improved weaning practices, thus limiting the prevalence of diarrhoea. Parental education is likely to have a major impact on curable and preventable diseases and on the nutritional intake of children. In our study, skin infections and diarrhoea negatively influenced anthropometry, and are synonymous with poor hygiene, sanitation, and socioeconomic conditions. Therefore health education directed at changing sanitation practices, hygiene, water supplies, and behaviour could considerably improve nutrition. Unfortunately many sanitation programmes fail because of the difficulty in changing deep-rooted behaviours, failure to assess perceptions, and the use of inappropriate sanitary technology. The impact of improvements to water supplies and environmental sanitation will be minimal if people do not change behavioural practices that pollute water and food. Educational efforts, can, however, result in a lower incidence of diarrhoea and other infections, with subsequently improved child growth.

Our results show that the predominant nutritional problem in the study community was stunting. A range of socioeconomic and environmental factors is likely to have been responsible. Parental education, independently of other variables, appeared to be particularly important in this respect, and the findings suggest the need for improved, appropriate education programmes for children and their parents, in addition to primary health care projects.

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Résumé

Déterminants de la nutrition et de la mortalité juvéniles dans le nord-ouest de l'Ouganda

Entre février et mars 1987, 1178 enfants âgés de 0 à 59 mois ont été sélectionnés dans 30 villages du district d'Arua, dans le nord-ouest de l'Ouganda. Diverses mesures anthropométriques ont été faites sur ces enfants et des données socio-économiques concernant les familles ont été recueillies. Les familles ont été revisitées un an plus tard et on a noté tous les décès survenus chez les enfants examinés.

La sensibilité des paramètres anthropométriques en tant que prédicteurs de la mortalité était la plus grande pour le rapport poids/âge lorsque la spécificité était supérieure à 88%; l'indicateur poids/taille était le plus sensible lorsque la spécificité était plus faible, et l'indicateur poids/âge était le moins sensible. Le choix d'un indicateur anthropométrique pour repérer les enfants ayant le risque le plus élevé de mortalité dépend par conséquent du niveau de spécificité; toutefois, comme les ressources sont limitées, un taux élevé de spécificité est habituellement exigé et dans ce cas l'indicateur poids/âge semble supérieur aux indicateurs poids/taille et taille/âge pour repérer les enfants chez qui le risque de mortalité est le plus élevé.

La mortalité juvénile était plus élevée dans les familles où la principale profession du père était en rapport avec la distillation de l'alcool, et plus faible lorsque le père travaillait dans une plantation de tabac ce qui indique que, dans la zone étudiée, ces professions correspondent à des conditions socio-économiques différentes.

L'état nutritionnel des nourrissons de moins de 6 mois était satisfaisant, mais se détériorait par la suite; la maigreur (faible poids pour l'âge) était plus fréquente chez les 6–24 mois, et était faible dans les autres groupes d'âge, alors que le retard de croissance (faible taille pour l'âge) était toujours important chez les plus de 5 mois. Les

variables suivantes étaient liées de façon significative aux résultats anthropométriques: niveau d'études des parents, allaitement au sein, utilisation de réserves d'eau non protégées en saison sèche, présence d'infections cutanées, et diarrhée. Ces variables sont probablement liées au mauvais état nutritionnel de par leur association avec la pauvreté, la sous-alimentation et les infections. L'allaitement au sein prolongé (au-delà de 12 mois) influait négativement sur l'état nutritionnel. Cette association peut être due à une alimentation plus réduite chez les enfants nourris au sein, ou au fait que ces enfants se trouvaient dans les familles les plus pauvres.

Dans la population étudiée, le principal problème nutritionnel est donc le retard de croissance, associé à des variables traduisant des conditions socio-économiques médiocres. Le retard de croissance résulte probablement d'une série de facteurs associés à des carences chroniques, notamment protéino-énergétiques, et également en oligo-éléments, aggravées encore par de fréquents épisodes infectieux. Il s'agit d'un problème nutritionnel chronique, dû à un stress nutritionnel prolongé provoqué par l'interaction d'une insuffisance alimentaire et d'infections. Son étiologie est plurifactorielle, mais il est clairement associé à la pauvreté et à l'insalubrité des conditions de vie, aucun facteur pris isolément n'étant entièrement à incriminer. Nous pouvons donc supposer qu'une amélioration du retard de croissance dans la population étudiée ne peut avoir lieu que s'il y a amélioration des conditions de vie et de l'approvisionnement de la famille, un plus large accès à une source d'eau saine, et également une amélioration de l'assainissement, de l'éducation sanitaire et nutritionnelle, des services de vaccination, de la lutte contre les maladies diarrhéiques et d'autres éléments des soins de santé primaires.

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